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Consumer Acceptability of Ghanaian Unpolished Rice Biscuits

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ABSTRACT

Majority of the cereals produced in Ghana go to waste due to poor patronage resulting from their under-utilization. In spite of the attributes or qualities of unpolished rice, its patronage by the local Ghanaians is on the low side even though it is available on the local market. To this effect the objective of the paper was to evaluate the consumer acceptability of unpolished rice biscuits. Proximate composition and sensory characteristics of unpolished local rice and wheat flours were determined using the A.O.A.C (2012) methods and preference test respectively. Five unique products viz., B, C, D and E containing unpolished local rice at levels of 25, 50, 75, 100% composite flour and a control were formulated to assess the quality and consumer acceptability of the biscuits. The proximate composition of unpolished local rice was 11.67% moisture, 0.52% ash, 0.40% fat, 6.88%, 0.35% crude fibre and 80.18% carbohydrate. Sensory evaluation of the products developed revealed that the control sample was significantly different (P<0.05) from the others and received a rating of like extremely for all attributes tested. Unpolished rice was found to be good composite flour, replacing wheat flour of up to 75 % without compromising on the quality of the sensory attributes tested.

Keywords: under-utilization, proximate, local rice, sensory

INTRODUCTION

Studies on the health impact of refined carbohydrates and of whole cereals are of great importance in the context of escalating obesity epidemic and related chronic diseases (Shobana *et al.,* 2011). Cereals such as rice and wheat are staple foods in developing countries (Khush, 2005; FAO, 2006) including Ghana. This has resulted in the world rice production growing from 468.5 million tons in the year 2010 to 482.7 metric tons in 2011, about 2.6% increase (FAO, 2012) with Ghana's rice production estimates ranging from 200,000 to 300,000 metric tons of paddy and roughly 120,000 to 130,000 metric tons of milled rice yearly ((Khush, 2005). Although rice has been a staple food for thousands of years (Toumilehto *et al.,* 2001), advancements in milling technologies to improve yield and shelf life have led to highly polished, starchy refined rice (Shobana *et al.*, 2011).

Unpolished cereals possess phytochemicals such as polyphenols, oryzanols, phytosterols, tocotrienols, tocopherols and carotenoids as well as vitamins and minerals that confer protection against cardiovascular diseases and cancer (Shobana *et al*., 2011; Dinesh *et al*., 2009) which is absent in polished cereals. Interestingly, refined rice is the staple food for majority of people in developing countries (Khush, 2005), where rise in the cause of type 2 diabetes has reached a crescendo (Shobana *et al*., 2011). Due to rice's high glycemic index (Miller *et al*., 1992), prolonged consumption may lead to disorders such as obesity, glucose intolerance, type 2 diabetes and cardiovascular diseases (Barclay *et al*., 2008).

Unpolished rice or brown rice is the entire grain with only the inedible outer husk removed (Sayre *et al*., 1982). The outer coating of unpolished rice contains added minerals and protein and considered to have greater nutrition value than the refined or polished rice counterpart. It contains 8% protein and a good source of the amino acids: thiamine and niacin (Acheampong, 2011).

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Consumer demand is increasing for composite flour based products like biscuits. As result of changing food habits, increasing population and urbanization, the consumption of leavened wheat baked products has risen dramatically in many developed and developing countries. For climatic reason many developing countries like Ghana cannot grow wheat suitable for baked products manufacturing. This has resulted in the country spending hard and expensive foreign exchange to supply wheat thus, putting stress on the economy.

Majority of the cereals produced in Ghana go to waste due to poor patronage resulting from their under-utilization. In spite of the attributes or qualities of unpolished rice, its patronage by the local Ghanaians is on the low side even though it is available on the local market. This situation has resulted in high postharvest losses which serve as a disincentive to the local producers of unpolished rice. There is therefore, the need to add value to the unpolished local rice to make it more attractive and also boost up patronage by transforming and using it in composite flour so that it can be used on multi-purpose basis other than solely boiled rice. To this effect the objective of the paper was to evaluate the consumer acceptability of unpolished rice biscuits.

MATERIALS AND METHOD

Materials

The ingredients used for the experiment were wheat flour, unpolished local rice or brown rice flour, margarine, sugar and eggs.

Sources of Ingredients

The test ingredients were purchased from the Kumasi Central Market.

Sample Preparation

The dried dehusked unpolished local rice was sorted out, washed twice, sun dried for a minimum of two days, milled using a hammer mill to a particle size of 0.2mm. The flour was packaged in a clean dry zip lock High Density Polyethylene (HDPE) container and kept in a cool dry place pending further analyses.

Physicochemical Properties on the Flour

The proximate composition of the flour was determined using the AOAC (2005) method.

Determination of Moisture Content

Moisture content was determined by the method of A.O.A.C. No. 945.38 (A.O.A.C., 2005). Two grams of unpolished rice flour were weighed and transferred into a previously dried and weighed glass crucible and placed in a hot air oven to dry at 105 °C for 5 h. Samples were cooled in a desiccator, weighed, and returned to the oven to dry to constant weight. Loss in weight was calculated as percentage moisture

Determination of Ash Content

Ash content was determined by the method of A.O.A.C. No. 936.07 (A.O.A.C., 2005). In this method, 2.0 g of dried unpolished rice flour from 3.5.1.1 were transferred into a pre-ignited and pre-weighed porcelain crucible and combusted in a muffle furnace at 600 °C for 2 h. The crucibles containing ash were cooled and re-weighed. Loss in weight was calculated as percentage ash content

Determination of Crude Fat Content

Crude fat determination followed the method of A.O.A.C. No. 2003.05 (A.O.A.C., 2005). Two grams of sample were transferred into a 22 × 80 mm paper thimble and capped with glass wool, dropped into a thimble holder and attached to a pre-weighed 500 ml round bottom flask containing 200 ml hexane and assembled on a semi-continuous soxhlet extractor. Contents of the thimble were refluxed for 16 h after which the hexane was recovered on a steam water bath. The flask containing the fat was heated for 30 minutes in an oven at 103 ^{o}C, cooled in a desiccator and weighed. Increase in weight of flask was recorded from which the percentage crude fat was calculated.

Determination of Protein Content

Protein content was measured following the Kjeldahl nitrogen determination of A.O.A.C. No.2001.11 (A.O.A.C., 2005). In this method, 2.0 g of dried unpolished rice flour in a Kjedahl flask was added to 25 ml concentrated (98 %) HS_2O_4 and digested till the colour of the solution turned clear. The solution was transferred into a 100 ml volumetric flask and the volume made up to the mark with distilled water. Ten milliliters of the solution were distilled and titrated against 0.1M hydrochloric acid against a blank. Titre values of duplicate samples were recorded and percentage nitrogen calculated. Percentage nitrogen (% N) was converted to percent crude protein by multiplying by a factor of 6.25.

Determination of Crude Fibre Content

Crude fibre was determined according to the procedure of A.O.A.C. 920.86 (A.O.A.C. 2005). To 2.0 g of defatted unpolished rice flour in a 750 ml Erlenmeyer flask was added to 200 ml of boiling 1.25% HS_2O_4 and refluxed for 45 min. The mixture was screened with cheese cloth and residue washed with large volumes of boiling water till filtrate was no longer acidic. The reflux was repeated with 1.25 % sodium hydroxide (NaOH), screened and washed to remove all alkali. The residue was transferred to a previously weighed porcelain crucible (M1), dried for 1h at 100°C, cooled in a desiccator and re-weighed (M2). The crucible was ignited in the muffle furnace at 600^{o}C for 30 min and re-weighed after cooling in a desiccator (M3). Increase in weight was calculated as percentage crude fibre (Appendix 5).

Determination of Available Carbohydrate Content

Available carbohydrate content was calculated by difference [(100- total of M)] where M is moisture + crude fat + ash + crude fibre + crude protein (A.O.A.C. No. 986.25) (A.O.A.C., 2005). All proximate determinations were done in triplicate.

Product Formulation

The biscuits were prepared with the incorporation of unpolished local rice flour concentration with wheat flour. Five (5) products namely, products A, B, C, D and E containing unpolished rice flour at levels of 0, 25, 50, 75 and 100% replacing equivalent amounts of wheat flour, were formulated. The percentage composition of the products is shown in Table 1. Apart from wheat flour and unpolished brown rice flour which were included at varying amounts for the five products, the other ingredients were included at the same levels for each of the products. The unpolished rice flour, wheat flour and other ingredients were weighed accurately into a basin. The fat was rubbed in until mixtures of fine bread crumbs were obtained. The sugar was then be mixed in. The egg was be beaten and added to bind the mixture to a stiff paste. It was then rolled out, cut into shapes and placed on a slightly greased baking sheet. It was baked in a moderate oven at 140ºC for 15 minutes, cooled to ambient temperature on racks.

Table1. *Formulation plan of unpolished rice biscuits*

Product Formulation					
Ingredients	A(Control)	B	C	D	E
Brown rice flour (g)	0	25	50	75	100
Wheat flour (g)	100	75	50	25	0
Sugar (g)	40	40	40	40	40
Margarine (g)	40	40	40	40	40
Egg	1	1	1	1	1
Salt (g)	0.25	0.25	0.25	0.25	0.25

A = 0% Brown rice (control);B = 25% Brown rice;C = 50% Brown rice;D = 75% Brown rice;E = 100% Brown rice.

Sensory Evaluation

Sensory evaluation was conducted by fifty (50) semi-trained panelists recruited from the Departments of Hospitality and Tourism Education, College of Technology Education, Kumasi. Panelists were introduced to the control biscuit and individual seven-point hedonic rating scale for five attributes, namely, colour, appearance, flavour (aroma), texture, taste and overall acceptability.

Statistical Analysis

Data collected was subjected to analysis of variance (ANOVA) using the software, statistical package for social science (SPSS).

REULTS AND DISCUSSIONS

Proximate Composition of Flours

The proximate composition of unpolished rice flour sample as analyzed is shown in Table 2.

Table2. *Mean proximate composition in percentage of unpolished rice and wheat flour*

Proximate Parameters	Unpolished rice (%)	Wheat
Moisture	$11.67^{a} \pm 0.05$	$13.04^{b} \pm 0.25$
Protein	$6.88^{a} \pm 0.05$	$12.28^{b} \pm 0.34$
Fat	$0.4^{a} \pm 0.03$	$1.82^{b} \pm 0.87$
Ash	$0.52^{a} \pm 0.03$	$1.43^{b} \pm 0.65$
Crude fibre	$0.35^{a} \pm 0.05$	$0.84^{b} \pm 0.01$
Carbohydrate	$80.18^{b} \pm 0.02$	$70.6^{a} \pm 0.92$

In the current study, the moisture content ranged between 11.67 and 13.04 % and were significantly different from each other ($P<0.05$), with unpolished rice recording the lowest moisture content while wheat flour recorded the highest moisture content. The relatively low moisture content recorded attests to the potential microbial stability of the flour samples. This result agrees with Clarke and Herbert (1992) who stated that all cereal grains contain very high proportions of carbohydrates (70-80%), protein (7-14 %) and water (11-14%). The protein, ash, crude fibre and fat contents were significantly lower than the typical percentage composition of cereal grains as indicated by Potter and Hotchkiss (1996) and also that of Islam *et al.* (2012). However, the carbohydrate and moisture contents were higher than those of Potter and Hotchkiss (1996) and Islam *et al.* (2012).

Sensory Evaluation of Biscuits

Colour

Colour generally refers to the appearance of the product. It is one of the sensory attributes consumers explore in purchasing new products due to its aesthetic appeal. The colour of the products produced from unpolished brown rice and wheat were evaluated and presented in Table 3.

Table3. *Descriptive statistics of colour of biscuits.*

Product Formulation					
Statistics	A	B	C	D	E
Mean	1.35^{a}	2.10^{b}	1.80^{b}	1.75^{b}	2.00^{b}
Std Dev.	0.59	1.25	0.77	0.79	1.03
Median	1.00	2.00	2.00	2.00	2.00
CV (%)	44	60	43	45	51
Min.	1	1	1	1	1
Max.	3	6	3	3	4

A = 0% Brown rice (control); B = 25% Brown rice; C = 50% Brown rice; D = 75% Brown rice; E = 100% Brown rice. Numbers in row followed by different superscripts are significantly different at 95% confidence interval

In the current study, panelists rated the colour of the various products between 1.35 and 2.00, with product A being rated as the best followed by D, C, E and B. From the hedonic scale, product A was rated to be like extremely while the rest of the products were rated like very much. The product A was significantly ($P < 0.05$) different from the rest of the products viz., B, C, D and E. Similar to this finding, Alice and Rosli (2005) reported that the sensory score of *Kuih Talam Pandami (KTP)* added with 30-90% of unpolished brown rice powder received significantly lower score for colour compared to the control sample. The results however, disagreed with Bunde *et al.* (2010) who reported no significant difference in colour the control biscuits and 10-40% unpolished rice flour biscuits. From the results, product B recorded the least score for colour and can be can be attributed to the levels of substitution in the composite flour. This is because wheat flour contributes to the development of desirable colour in baked products.

Aroma

Aroma of a product is the sensation perceived by the nose (Potter and Hotchkiss, 1996). Most products are patronized by consumers due to their aroma. Table 4 shows the evaluated aroma of products produced from unpolished brown rice and wheat.

Table4. *Descriptive statistics of the aroma of biscuits.*

Product Formulation					
Statistics	A	B	C	D	E
Mean	1.50[a]	1.95[b]	1.75[a]	1.95[b]	2.00[b]
Std Dev.	0.61	0.76	0.85	0.89	0.86
Median	1.00	2.00	2.00	2.00	2.00
CV(%)	41	39	49	46	43
Min.	1	1	1	1	1
Max.	3	3	4	4	3

A = 0% Brown rice (control); B = 25% Brown rice; C = 50% Brown rice; D = 75% Brown rice; E = 100% Brown rice. Numbers in row followed by different superscripts are significantly different at 95% confidence interval

The mean scores of sensory evaluation for aroma ranged between 1.50 and 2.00. Product C (50% wheat, 50% unpolished brown rice) did not differ significantly in aroma with the control while all the other products showed significant difference ($P<0.05$) from the control. Preference for aroma of biscuits products decreased with increasing level of substitution of unpolished brown rice. Product A (Control) recorded the highest mean value with product E recording the lowest mean value. Product A thus received the highest rating followed by C, B, D and E respectively. The hedonic Scale indicated that product A was extremely liked, product C moderated liked with the other products like moderately. Product E had the lowest score because there was no wheat flour in the formula. This result may be associated with Bor (2003) who reported that fresh rice bran is associated with volatile compounds and its aroma is composed of alcohols and carbonyls, which could be a hindering factor in its use as an ingredient in human foods. This result is similar to Bunde *et al*. (2010). It can be deduced that, even though product A was most preferred for aroma, product C (50% wheat and 50% unpolished brown rice) could be developed for use.

Taste

Taste is one of the sensory characteristics that refer to sensation perceived by the tongue which include sweet, salty, sour and bitter (Potter and Hotchkiss, 1996). The taste of the products produced from unpolished brown rice and wheat were evaluated and presented in Table 5. The mean score of the taste attribute of the control biscuit (0% unpolished brown rice) was significantly ($P < 0.05$) higher than biscuits containing unpolished brown rice flour. The taste of biscuits containing unpolished brown rice (products B, C, D and E) were not significantly different among themselves (Table 5). According to Ayo *et al.* (2007) Rice bran has a characteristic bland flavor that is neither bitter nor sweet. The flavor is described as insipid rancid, musty and sour due to its ready deterioration in commercial lots. Rosniyana *et al.* (2005) reported that rice bran present in the unpolished brown rice flour had a sweet, slightly toasted, nutty flavour which may be the main contributing factor in affecting the taste of the biscuits. The recorded results may be associated with these reasons. The results also revealed that the panelists preferred the taste of the control (product A) followed by D, E, B and C respectively. From the hedonic scale, the taste of product A was rated extremely liked with the rest rated very much liked. The score of the taste attribute obtained in this study was similar to those of Alice and Rosli (2015) and Islam *et al.* (2012).

Table5. *Descriptive statistics of the taste of biscuits*

Product Formulation					
Statistics	A	B	C	D	E
Mean	1.35[a]	2.20[b]	2.30[b]	1.85[b]	2.05[b]
Std Dev.	0.59	1.28	0.57	0.75	0.83
Median	1.00	2.00	2.00	2.00	2.00
CV(%)	44	58	25	40	40
Min.	1	1	1	1	1
Max.	3	6	4	3	4

A = 0% Brown rice (control); B = 25% Brown rice; C = 50% Brown rice; D = 75% Brown rice; E = 100% Brown rice. Numbers in row followed by different superscripts are significantly different at 95% confidence interval

After Taste

After taste refers to the comments or remarks made by the panelists after tasting the products. In this study, the remarks made by the panelists after tasting the products were rated between 1.40 and 2.32 as presented in Table 6.

Table6. *Descriptive statistics of the after taste of biscuits.*

Product Formulation					
Statistics	A	B	C	D	E
Mean	1.40[a]	2.20[b]	2.32[b]	1.95[b]	2.10[b]
Std Dev.	0.68	1.20	0.82	0.60	0.91
Median	1.00	2.00	2.00	2.00	2.00
CV (%)	49	54	35	31	43
Min.	1	1	1	1	1
Max.	3	6	4	3	4

A = 0% Brown rice (control); B = 25% Brown rice; C = 50% Brown rice; D = 75% Brown rice; E = 100% Brown rice. Numbers in row followed by different superscripts are significantly different at 95% confidence interval

From the results, product A was significantly ($P < 0.05$) different from the rest of the products. Product A recorded the highest mean mark and was rated as the best followed by D, E, B and C respectively. From the hedonic scale, product A was rated to be extremely liked and the rest of the products were rated very much liked. Products B, C, D and E were similar in after taste rating with product C (50% wheat flour and 50% unpolished brown rice flour) recording the worse score. This means that the panelists remarked that products B, C, D and E had bitter after taste. According to Bunde *et al.* (2010) the after taste bitterness remarks on samples of biscuits with higher levels of unpolished brown rice flour substitution were subjective to age, since adult panelists seemed to prefer these samples. The bitter after taste may be associated with the presence of saponin in the rice bran found in unpolished brown rice flour. Rosniyana *et al.* (2005) reported that bitter taste of unpolished brown rice is associated with saponin present in the rice bran found in unpolished brown rice powder and the amount of saponin in the products depends on the levels of the unpolished brown rice powder in the formulation of the product. This result is also similar to those of Alice and Rosli (2015) and Islam *et al.* (2012).

Overall Acceptance

Consumers choose foods based on the quality which is the degree of excellence and include taste, appearance and nutritional content which have significance and make for acceptance (Potter and Hotchkiss, 1996).Table 4.5 shows the overall acceptance of biscuits.

Table7. *Descriptive statistics of overall acceptance of biscuits.*

Product Formulation					
Statistics	A	B	C	D	E
Mean	1.45^{a}	1.95^{b}	1.90^{b}	1.85^{b}	1.75^{b}
Std Dev.	0.51	1.78	0.72	0.75	0.85
Median	1.00	2.00	2.00	2.00	2.00
CV (%)	35	40	38	40	49
Min.	1	1	1	1	1
Max.	2	3	3	3	3

A = 0% Brown rice (control); B = 25% Brown rice; C = 50% Brown rice; D = 75% Brown rice; E = 100% Brown rice. Numbers in row followed by different superscripts are significantly different at 95% confidence interval

In the current study, panelists rated the overall acceptance of the various products between 1.45 and 1.95. The panelists preferred the control (0% unpolished brown rice) which had the highest score (1.45) for the overall acceptability of biscuits. Biscuit added with 25% unpolished rice was the least preferred product which had lowest score (1.95). Product A was significantly ($P < 0.05$) different from the rest of the products. From the hedonic scale, product A was rated to be liked extremely with the rest of the product rated to be very much liked. The acceptability scores for the current study support the statement made by Potter and Hotchkiss (1996) that consumers choose foods based on the quality which is the degree of excellence and include taste, appearance, texture, colour, odour and nutritional content which have significance and make for acceptance. This result is similar to Alice and Rosli (2015) and Islam *et al.* (2012). Increase in acceptability was observed as the level of substitution of unpolished brown rice increased. The trend was as follows product A was the highest followed by E (100% unpolished brown rice), D (75% unpolished brown rice), C (50% unpolished brown rice) and B (25% unpolished brown rice). Product A (100% wheat flour) was extremely accepted because of the gluten content of wheat flour. Adigbo and Madah (2010) reported that wheat flour is preferred or used more often than other types of flour because of its gluten content which gives it the elastic nature.

CONCLUSION

The results of the study showed that unpolished local rice flour has high carbohydrate, protein and moisture contents comparable to wheat flour. The sensory evaluation showed that biscuit without the addition of unpolished brown rice flour was generally preferred for all the attributes. Apart from that, among biscuits added with unpolished local rice, the biscuit with 75% unpolished local rice flour had the highest score for colour, taste and after taste and next in overall acceptance to 100% unpolished local rice flour which was highly accepted by the panelists. The incorporation of increasing levels of unpolished local rice flour into the biscuit increased the overall acceptability of the biscuits. Generally, the addition of 75% and 100% unpolished local rice flour in biscuits could be recommended as the ideal level of preparing biscuits.

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